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mens in our series, one of which is very similar to that referred to from the Yorkshire wolds. The others have the bowl of the spoon not so well defined, but otherwise are well made scrapers. There are also three other specimens, that might be more properly called knife-shaped scrapers, in that the bowl and stem or handle are of the same width. The scraping edge is, however, circular, as in the true spoon-shaped form. These may be looked upon as connecting links with the quadrangular or horseshoe-shaped scrapers. There remains one other specimen to notice, being a " side scraper," as Mr. Evans calls this form, that is, one that is broader than it is long. It is made of slate, chipped with some care; is two inches in length by three in width. Both sides are adapted to scraping, being each well chipped, with the lower side flatter than the upper surface. What perhaps might be called the true edge, is somewhat more extended than the other, from the barblike projections at either end, which barbs give a finished appearance to the implement, which otherwise might have been looked upon as merely a flake or unfinished specimen. This form of scraper is not common with us.

After a careful study of these and many other specimens of this form of implement, found in New Jersey, we have determined, we think:

First. That jasper, quartz and allied minerals were preferred in manufacturing scrapers.

Secondly. That as much care was taken in their shaping and finishing, as was the case with arrowpoints and spearpoints.

Thirdly. That but few "flakes" were utilized in making scrapers, as is the case with European specimens.

Fourthly. That the majority of scrapers were intended to be inserted in handles of bone or wood.

Fifthly. That large spearheads especially, and some arrowheads were used for making scrapers, having previously lost their points, and being too short to be repointed.

Lastly. That, as a class, the New Jersey scrapers are smaller than those found in Europe.—CHARLES C. ABBOTT, M.D.

MICROSCOPY.

IMPROVEMENTS IN OBJECTIVES.—Mr. Wenham has placed microscopists, and indeed all persons interested in scientific progress, under a new obligation, by his last paper on object-glasses, contributed to the Royal Microscopical Society. He seems to be strangely unconscious of the fact that he cares more for human progress than for trade secrets; and he publishes, with the utmost apparent indifference, exactly what the world wants to know, but what it knows too well would be by most persons devoted to secrecy and to personal business purposes.

Introductory to an explanation of his new formula for objectives, Mr. Wenham reviews the history of the modern (English) objectives.

In the year 1829, before which time three superposed achromatic lenses were employed simply as a means of increasing power, the late Mr. Lister discovered and published the law of aplanatic foci, that by separating suitably connected lenses one or two positions could be found in which spherical aberration was balanced; and Mr. Ross constructed in 1831, with unexpected success, the first objective embodying this principle. Mr. Ross then discovered that the interposition of a cover-glass removed the aplanatic focus to a different plane, causing negative aberration and requiring the lenses to be brought closer together; and he therefore introduced the screw collar adjustment which has now become universal. These objectives consisted of three pairs, the double convex crown and plano-concave flint of each pair having their contact surfaces of equal radius and balsamed together, the three pairs having foci about in the proportion of one, two, three, and the anterior pair being at a considerable and variable distance from the other two pairs. In this combination the softness of the flint glass forming the first plane surface was unfortunate, and the angular aperture of a $\frac{1}{8}$ was limited to 60°.

In the year 1837, Mr. Lister furnished Mr. Ross a diagram of a triple front lens, consisting of a plano-concave of flint between two plano-convex crowns, for the purpose of protecting the flint from the exposure to the air and of diminishing the depth of curvature, which was unfavorable for the passage of the marginal rays. The front surface of the middle pair was made concave with no other advantage than reducing the depth of contact, and it may be made a plane with at least equally good results in correction of the oblique pencils and in flatness of field. An angle of 80° was attained, by this method, in one-eighths.

Thirteen years later Mr. Lister introduced the triple-back, for the same objects as the triple front, it being composed of a double concave of very dense flint between a plano-convex and a double convex of crown. Thus more marginal rays were collected, and the aperture of a $\frac{1}{8}$ raised to 130° or over.

At that time Mr. Wenham, experimenting in the construction of objectives, discovered that excessive over correction or negative aberration was easily obtained with lenses of shallow contact curves, and that color correction was chiefly controlled by changes in the triple back, the rays passing through the concave flint of the triple front so nearly in the direction of its radii that great changes in its curvature possessed only feeble chromatic effects. This led him to introduce the now familiar single front of plano-convex crown glass which was long rejected by the leading opticians, but is now used by all of them. The first $\frac{1}{8}$ constructed on this system possessed an angular aperture of 130°, and was successful at first attempt, the middle pair being neutral or nearly achromatic and the triple back happening to have a suitable excess of negative aberration or over correction for color. Some positive spherical aberration remained, which was remedied by giving additional thickness to the front lens; a correction now considered essential and requiring great delicacy, as a difference in thickness of $\frac{1}{500}$ inch will determine the quality between a good and an indifferent $\frac{1}{15}$.

The excessive depth of the contact surfaces of the middle pair was a remaining defect, it being so great that if not balsam cemented, total reflection of the marginal rays would take place, and the angular aperture be reduced. Though the surfaces are obliterated by being cemented with balsam and the rays are thus enabled to proceed, still an angle beyond that of total reflection, implies excessive and detrimental depth of curvature. Placing the flint in the form of a meniscus above a plano-convex crown was employed as a middle pair with some satisfaction. An attempt was also made to obtain the whole chromatic correction with the biconcave flint of the back, the middle as well as the front being a single uncorrected plano-convex of crown. Sufficient over correction was obtained by the back to balance both the other lenses, but the red and blue rays, for instance, had become so widely separated in the front and middle lenses and between them when placed for aplanatic foci, that they could not be brought together again at the point of leaving the back lens, and must either leave it converging to some one fixed conjugate focus, or else parallel but not united; in the first case the combination could only be applicable to one fixed length of body, and in the other it would not be satisfactory under any conditions. The cure for this seemed to be, and proved to be, to transpose the single middle and the triple back; the over corrected triple bringing together the rays which had been separated by the single front, and the single lens of longer focus making the rays parallel at the point of final emergence. The single front is nearly alike in all cases, varying only with the power required; the triple middle is of about three times, and the single plano-convex back four and a half times the radius of the front. The single plano-convex of long focus is reversed when transferred from the middle to the back position, the plane surface being above instead of below. Perfect color correction can be obtained by this formula in all screw collar objectives, from $\frac{1}{2}$ inch upwards. This combination consists of five lenses and ten surfaces, taking the place of eight lenses with sixteen surfaces.

These results are worked out by diagrams more easily than by mathematical computation; the course of the rays being projected by means of proportional compasses, with surprising accuracy, on a scale of some fifty times the size of the real combination.

TOLLES' TRIPLETS. — A correspondent writes as follows regarding a half inch triplet lately made by Mr. Tolles. "I am greatly pleased with the lens. Its performance is *splendid*, and it really gives the naturalist when away from his microscope an extraordinary facility. I should be very sorry to be without it." We quote this from our friend's letter, which was by no means designed for publication. These triplets certainly surpass anything of the kind we have met with. Mr. Tolles has just finished a $\frac{1}{75}$ objective, which is perfectly satisfactory to himself.

NOTES.

IT is seldom that the sad record we are now obliged to make occurs in a single number of a magazine:—the loss by death of four valued contributors within so short a time.

Prof. JOHN LEWIS RUSSELL, of Salem, died on the 7th of June, in the 65th year of his age. Prof. Russell was one of the founders,